7094

BEAM POWER TUBE

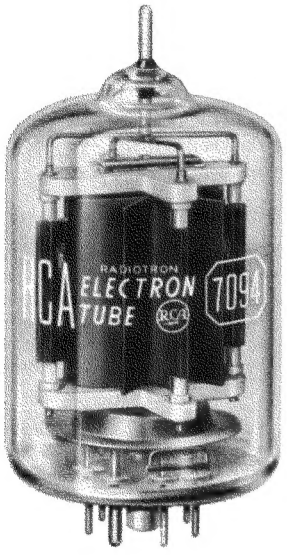
High Power Gain
Sturdy Structure

500 Watts CW Input (ICAS) Up to 60 Mc
335 Watts CW Input (ICAS) at 175 Mc
Forced-Air Cooled at Max. Ratings

5" Max. Length
2.56" Max. Diameter

TENTATIVE DATA

RCA-7094 is a high-perveance beam power tube with high power gain. It is useful in fixed and mobile equipment as an rf power amplifier and oscillator, as well as an af power amplifier and modulator.



The 7094 has a maximum plate dissipation of 125 watts under ICAS conditions in modulator service and in cw service. In the latter service it can be operated with full input to 60 Mc and with reduced input to 175 Mc.

Because of its high power gain, the 7094 can be operated with relatively low plate voltage to give large power output with small driving power.

Small and compact for its power-output capability, the 7094 has a rugged button-stem construction with short internal leads, internal shield connected to grid No.2 within the tube, triple base-pin connections for grid No.2 to permit effective rf grounding, plate structure with large radiating fins for effective cooling, and ceramic mount supports to provide additional sturdiness to the electrode structure. The plate lead is brought out of bulb to a rigid terminal opposite the base to facilitate separation of input and output circuits.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3 ± 10%	volts
Current at 6.3 volts	3.2	amperes
Transconductance (Approx.) for plate volts = 300, grid-No.2 volts = 300, and plate ma = 250	10000	μmhos
Mu-Factor, grid No.2 to grid No.1 for plate volts = 300, grid-No.2 volts = 300, and plate ma = 250.	7	
Direct Interelectrode Capacitances (With no external shield):		
Grid No.1 to plate⊕	0.5	μμf
Grid No.1 to grid No.2 & internal shield⊕	9	μμf
Grid No.1 to cathode and heater⊕	9	μμf
Grid No.2 & internal shield to plate⊕	9	μμf
Grid No.2 & internal shield to cathode and heater⊕	2.8	μμf
Plate to cathode and heater⊕	1.8	μμf

Mechanical:

Operating Position	Any
Maximum Overall Length	5"
Seated Length	4.44" ± 0.08"
Maximum Diameter	2.56"
Base	Jumbo-Button Septar 7-Pin (JETEC No.E7-46)
Socket	NATIONAL* HX29
Weight (Approx.)	6 oz
Bulb Temperature (At hottest point)	250 max. °C

Cooling: Free circulation of air around the tube is required. Under operating conditions at maximum ratings, some forced-air cooling will be required from a small fan to prevent exceeding the specified maximum bulb temperature.

AF POWER AMPLIFIER & MODULATOR -- Class AB$_1$♦

	CCS●	ICAS●●	
Maximum Ratings, *Absolute Values:*			
DC PLATE VOLTAGE	1500 max.	2000 max.	volts
DC GRID-NO.2 (SCREEN) VOLTAGE	400 max.	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT□	350 max.	350 max.	ma
MAX.-SIGNAL PLATE INPUT□	300 max.	400 max.	watts
MAX.-SIGNAL GRID-NO.2 INPUT□	20 max.	20 max.	watts
PLATE DISSIPATION□	100 max.	125 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts
Typical Operation: *Values are for 2 tubes*			
DC Plate Voltage	1500	2000	volts
DC Grid-No.2 Voltage§	400	400	volts
DC Grid-No.1 (Control-Grid) Voltage**	−50	−50	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	88	88	volts
Zero-Signal DC Plate Current	60	60	ma
Max.-Signal DC Plate Current	400	400	ma
Max.-Signal DC Grid-No.2 Current	70	70	ma
Effective Load Resistance (Plate to plate)	8700	12000	ohms
Max.-Signal Driving Power (Approx.)	0	0	watts
Max.-Signal Power Output (Approx.)	410	560	watts

* National Company, Inc., 61 Sherman Street, Malden, Mass.

TMK ®, Marca Registrada
Printed in U.S.A

ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

LINEAR RF POWER AMPLIFIER -- Class AB$_1$ Single-Sideband Suppressed-Carrier Service

	CCS●	ICAS●●	
Maximum Ratings, *Absolute Values up to 60 Mc:*			
DC PLATE VOLTAGE	1500 max.	2000 max.	volts
DC GRID-No.2 (SCREEN) VOLTAGE	400 max.	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT	350 max.	350 max.	ma
MAX.-SIGNAL PLATE INPUT	300 max.	400 max.	watts
MAX.-SIGNAL GRID-No.2 INPUT	20 max.	20 max.	watts
PLATE DISSIPATION	100 max.	125 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts
Typical Operation for "Single-Tone Modulation" at 60 Mc:●●			
DC Plate Voltage	1500	2000	volts
DC Grid-No.2 Voltage§	400	400	volts
DC Grid-No.1 (Control-Grid) Voltage**	−50	−50	volts
Max.-Signal Peak RF Grid-No.1 Voltage	44	44	volts
Zero-Signal DC Plate Current	30	30	ma
Max.-Signal DC Plate Current	200	200	ma
Max.-Signal Grid-No.2 Current	35	35	ma
Effective RF Load Resistance	4350	6000	ohms
Max.-Signal Driver Power Output (Approx.)	4	4	watts
Output-Circuit Efficiency (Approx.)	90	90	%
Max.-Signal Useful Power Output (Approx.)	185㊋	250㊋	watts

PLATE-MODULATED RF POWER AMPLIFIER-- Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

	CCS●	ICAS●●	
Maximum Ratings, *Absolute Values:*			
For max. plate voltage and max. plate input above 60 Mc, see Rating Chart I			
DC PLATE VOLTAGE	1000 max.	1200 max.	volts
DC GRID-No.2 (SCREEN) VOLTAGE	400 max.	400 max.	volts
DC GRID-No.1 (CONTROL-GRID) VOLTAGE	−300 max.	−300 max.	volts
DC PLATE CURRENT	280 max.	280 max.	ma
DC GRID-No.1 CURRENT	25 max.	30 max.	ma
PLATE INPUT	250 max.	335 max.	watts
GRID-No.2 INPUT	13.5 max.	13.5 max.	watts
PLATE DISSIPATION	67 max.	83 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts
Typical Operation at 60 Mc:			
DC Plate Voltage	1000	1200	volts
DC Grid-No.2 Voltage▲	400	400	volts
DC Grid-No.1 Voltage★	−130	−130	volts
Peak RF Grid-No.1 Voltage	145	150	volts
DC Plate Current	250	275	ma
DC Grid-No.2 Current	20	20	ma
DC Grid-No.1 Current (Approx.)	5	5	ma
Driver Power Output (Approx.)★▲▲	5	5	watts
Output-Circuit Efficiency (Approx.)	90	90	%
Useful Power Output (Approx.)	165㊋	240㊋	watts
Typical Operation at 175 Mc:			
DC Plate Voltage	700	820	volts
DC Grid-No.2 Voltage▲	400	400	volts
DC Grid-No.1 Voltage★	−130	−130	volts
DC Plate Current	250	275	ma
DC Grid-No.2 Current	8	8	ma
DC Grid-No.1 Current (Approx.)	6	6	ma
Driver Power Output (Approx.)▲▲	8	8	watts
Output-Circuit Efficiency (Approx.)	85	85	%
Useful Power Output (Approx.)	105㊋	135㊋	watts
Maximum Circuit Values:			
Grid-No.1-Circuit Resistance‡	30000 max.	30000 max.	ohms

RF POWER AMPLIFIER & OSC.--Class C Telegraphy† and RF POWER AMPLIFIER--Class C FM Telephony

	CCS●	ICAS●●	
Maximum Ratings, *Absolute Values:*			
For max. plate voltage and max. plate input above 60 Mc, see Rating Chart II			
DC PLATE VOLTAGE	1250 max.	1500 max.	volts
DC GRID-No.2 (SCREEN) VOLTAGE	400 max.	400 max.	volts
DC GRID-No.1 (CONTROL-GRID) VOLTAGE	−300 max.	−300 max.	volts
DC PLATE CURRENT	340 max.	340 max.	ma
DC GRID-No.1 CURRENT	25 max.	30 max.	ma
PLATE INPUT	375 max.	500 max.	watts
GRID-No.2 INPUT	20 max.	20 max.	watts
PLATE DISSIPATION	100 max.	125 max.	watts
PEAK HEATER-CATHODE VOLTAGE:			
Heater negative with respect to cathode	135 max.	135 max.	volts
Heater positive with respect to cathode	135 max.	135 max.	volts
Typical Operation at 60 Mc:			
DC Plate Voltage	1000	1250	1500 volts
DC Grid-No.2 Voltage□□	400	400	400 volts
DC Grid-No.1 Voltage⊕⊕	−100	−100	−100 volts
Peak RF Grid-No.1 Voltage	125	120	125 volts
DC Plate Current	330	300	330 ma
DC Grid-No.2 Current	20	18	20 ma
DC Grid-No.1 Current (Approx.)	5	5	5 ma
Driver Power Output (Approx.)★▲▲	4	4	4 watts
Output-Circuit Efficiency (Approx.)	90	90	90 %
Useful Power Output (Approx.)	215㊋	225㊋	340㊋ watts
Typical Operation at 175 Mc:			
DC Plate Voltage	665	875	1000 volts
DC Grid-No.2 Voltage□□	400	400	400 volts
DC Grid-No.1 Voltage⊕⊕	−100	−100	−100 volts
DC Plate Current	335	300	335 ma
DC Grid-No.2 Current	8	7	8 ma
DC Grid-No.1 Current (Approx.)	5	5	5 ma
Driver Power Output (Approx.)▲▲	8	7	8 watts
Output-Circuit Efficiency (Approx.)	85	85	85 %
Useful Power Output (Approx.)	130㊋	170㊋	215㊋ watts
Maximum Circuit Values:			
Grid-No.1-Circuit Resistance‡	30000 max.		ohms

⊕ All other elements are grounded.

♦ Subscript 1 indicates that grid-No.1 current does not flow during any part of the input cycle.

● Continuous Commercial Service.

●● Intermittent Commercial and Amateur Service.

□ Averaged over any audio-frequency cycle of sine-wave form.

§ Obtained preferably from a fixed supply.

** Obtained from a fixed supply.

♧ This value of useful power is measured at load of output circuit having indicated efficiency.

♦♦ "Single-Tone Modulation" operation refers to that class of amplifier service in which the grid-No.1 input consists of a monofrequency rf signal having constant amplitude. This signal is produced in a single-sideband suppressed-carrier system when a single audio frequency of constant amplitude is applied to the input of the system.

▲ Obtained preferably from a separate source modulated along with the plate supply, or from the modulated plate supply through a series resistor. It is recommended that this resistor be adjustable to permit obtaining the desired operating plate current after initial tuning adjustments are made.

★ Obtained from a grid-No.1 resistor or from a combination of grid-No.1 resistor with either fixed supply or cathode resistor. The combination of grid resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias-supply compensation.

♣ Indicated values are for operation at 60 Mc. Less driver power output is required at frequencies below 60 Mc.

▲▲ Driver stage is required to supply tube losses and rf circuit losses. The driver stage should be designed to provide an excess of power above the indicated values to take care of variations in line voltage, in components, in initial tube characteristics, and in tube characteristics during life.

‡ When grid No.1 is driven positive the total dc grid-No.1-circuit resistance should not exceed the specified maximum value of 30000 ohms. If this value is insufficient to provide adequate bias, the additional required bias must be supplied by a cathode resistor or fixed supply.

† Key-down conditions per tube without amplitude modulation. Amplitude modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

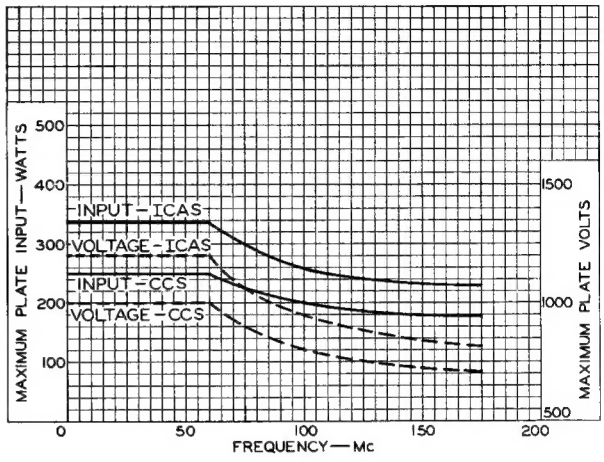
□□ Obtained preferably from a separate source or from the plate-voltage supply with a voltage divider. If a series resistor is used, it should be adjustable to permit obtaining the desired operating plate current after initial tuning adjustments are completed. Grid-No.2 voltage must not exceed 500 volts under key-up conditions.

⊕⊕ Obtained from a grid-No.1 resistor, or from a combination of grid-No.1 resistor with either fixed supply or cathode resistor.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data for the 7094 are limiting values above which the serviceability of the 7094 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value below each absolute rating by an amount such that the absolute values will never be exceeded under any usual condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

The *maximum bulb temperature* of 250° C is a tube rating and is to be observed in the same manner as other ratings. The temperature should be measured at the hottest point on the bulb with the tube operating in the completely assembled equipment with all covers in place, and delivering the maximum output under the highest ambient-temperature conditions and the most severe operating cycle for which the equipment is designed. The temperature may be measured with temperature-sensitive paint, such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y., in the form of liquid and stick.



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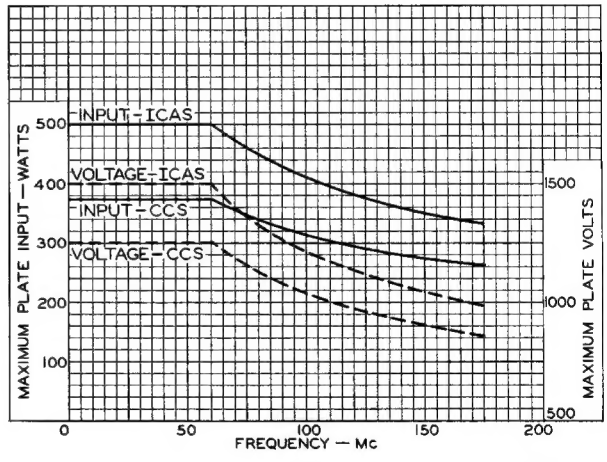
Rating Chart I for Type 7094 in Class C Telephony Service.



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Rating Chart II for Type 7094 in Class C Telegraphy Service.

Operation of the 7094 at frequencies above 60 Mc requires reduction in the applied plate

voltage and plate input as shown by the Rating Charts I and II. In using these charts, it is to be noted that the maximum plate input that can be applied to the 7094 operating at any given frequency must be chosen, depending on circuit efficiency, so that the plate-dissipation rating of the 7094 will not be exceeded.

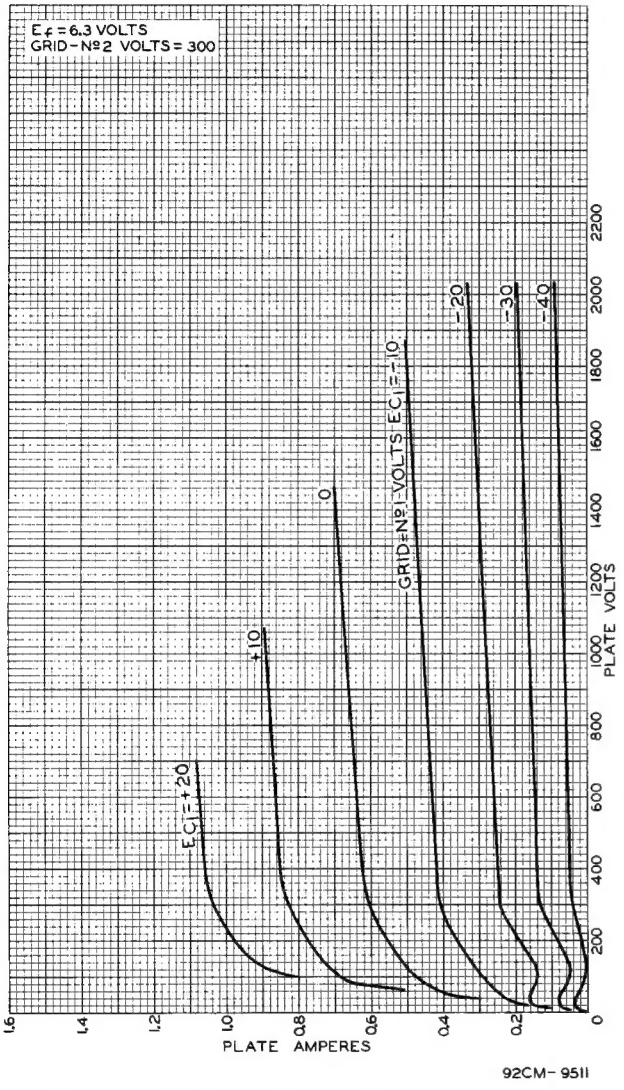


Fig. 1 - Typical Plate Characteristics of Type 7094.

The rated plate voltage and grid-No. 2 voltage of this tube are high enough to be dangerous to the user. Care should be taken during adjustment of circuits, especially when exposed circuit parts are at high dc potential.

When a new circuit is tried or when adjustments are made, it is advisable to reduce the plate voltage and grid-No. 2 voltage.

A *protective device*, such as a fuse, should be used to protect not only the plate but also grid No. 2 against overload. In order to prevent excessive plate-current flow and resultant overheating of the tube, the plate circuit should be fused. Similarly, a fuse in the lead to grid No. 2 should remove the grid-No. 2 voltage when the dc grid-No. 2 current reaches a value slightly higher than normal.

The *base pins* of the 7094 fit the standard transmitting seven-contact socket designed for use with the septar 7-pin base, such as Johnson No. 122-105.

Shielding of the 7094 in rf service is required for stable operation. A convenient method of shielding is to mount the socket approximately 5/8" beneath a hole in the chassis plate so that when the 7094 is inserted in the socket, the internal shield *(see Dimensional Outline)* of the tube will be close to the edge of the hole and in the same plane as the chassis plate. This arrangement provides an effective shield to isolate the grid-No. 1 circuit from the plate circuit.

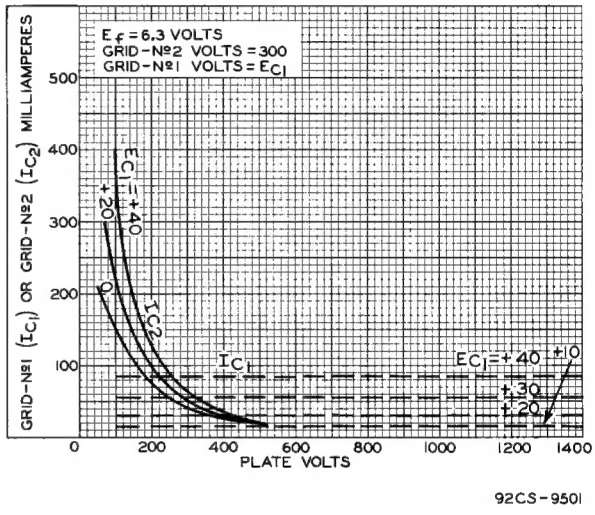


Fig. 2 - Typical Characteristics for Type 7094.

The connection to the plate terminal should be flexible in order to prevent subjecting the plate-terminal seal to any strain. The connection should never be soldered to the plate terminal. A plate connector of the heat-radiating type is recommended.

Heavy leads and conductors together with suitable insulation should be used in all parts of the rf plate tank circuit so that losses due to rf voltages and currents may be kept at a minimum. At the higher frequencies, it is essential that short, heavy leads be used for circuit connections in order to minimize lead inductance and losses.

The *plate* shows no color when the 7094 is operated at maximum rated plate dissipation under CCS conditions. At maximum rated plate dissipation under ICAS conditions, the plate may show a barely discernible color in a dark room.

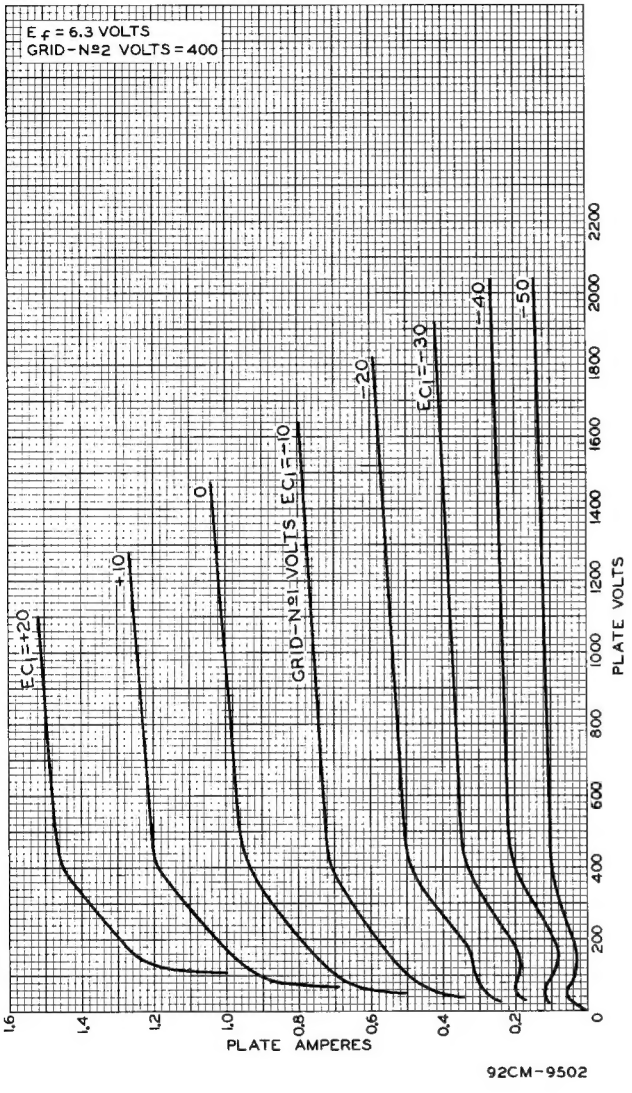


Fig. 3 - Typical Plate Characteristics of Type 7094.

The *cathode* should preferably be connected to one side of the heater. When, in some circuit designs, the heater is not connected directly to the cathode, precautions must be taken to hold the peak heater-cathode voltage to the maximum values shown in the tabulated data.

When *grid-No. 2 voltage* is obtained from a separate source, the plate voltage should be applied before or simultaneously with the grid-No. 2 voltage; otherwise, with voltage on grid No. 2 only, its current would be large enough to cause excessive grid-No. 2 dissipation even though some protective bias is employed. When the grid-No. 2 voltage is obtained from a voltage divider or through a series resistor from the plate supply, it is recommended that the resistor be adjustable so that the plate current of individual tubes can be adjusted to maintain the desired input. By thus compensating for the normal plate-current variation between tubes, the dc plate input can be held constant to provide more uniform power output and better performance. A dc milliammeter should be used in the grid-No. 2 circuit so that its current may be measured and the dc power input determined.

The *rf impedance between grid No. 2 and the cathode* must be kept low, usually by means of a

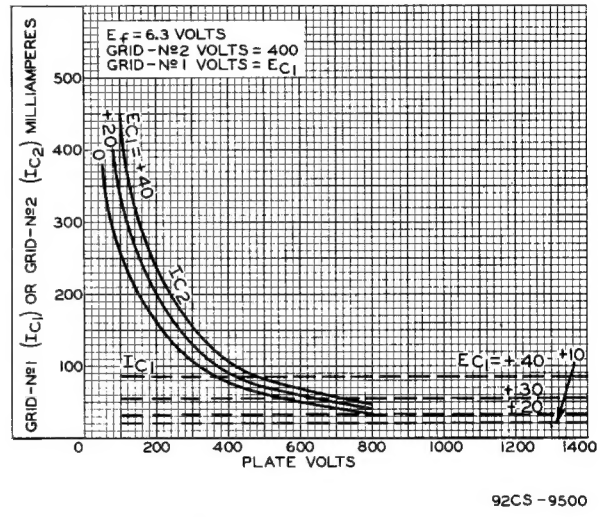


Fig. 4 - Typical Characteristics for Type 7094.

suitable bypass capacitor. In telephony service when grid No. 2 is modulated, a smaller bypass capacitor than is used for telegraphy service may be required in order to avoid excessive af bypassing. However, if the capacitance value is too small, rf feedback may occur between plate and grid No. 1, depending on the circuit layout, operating frequency, and power gain of the stage. AF bypassing difficulties can usually be eliminated if the grid-No. 2 bypass capacitor is replaced by a series-resonant circuit which is tuned to resonate at the operating frequency. This circuit presents a high impedance to audio frequencies but a very low impedance to its resonant frequency.

The *grid-No. 2 current* is a very sensitive indication of plate-circuit loading. When the amplifier is operated without load, the grid-No. 2 current rises excessively, often to a value which damages the tube. Therefore, care should be taken when tuning the 7094 under no-load or

lightly loaded conditions to prevent exceeding the grid-No.2 input rating of the tube. In this connection, reduction of the grid-No.2 voltage will be helpful.

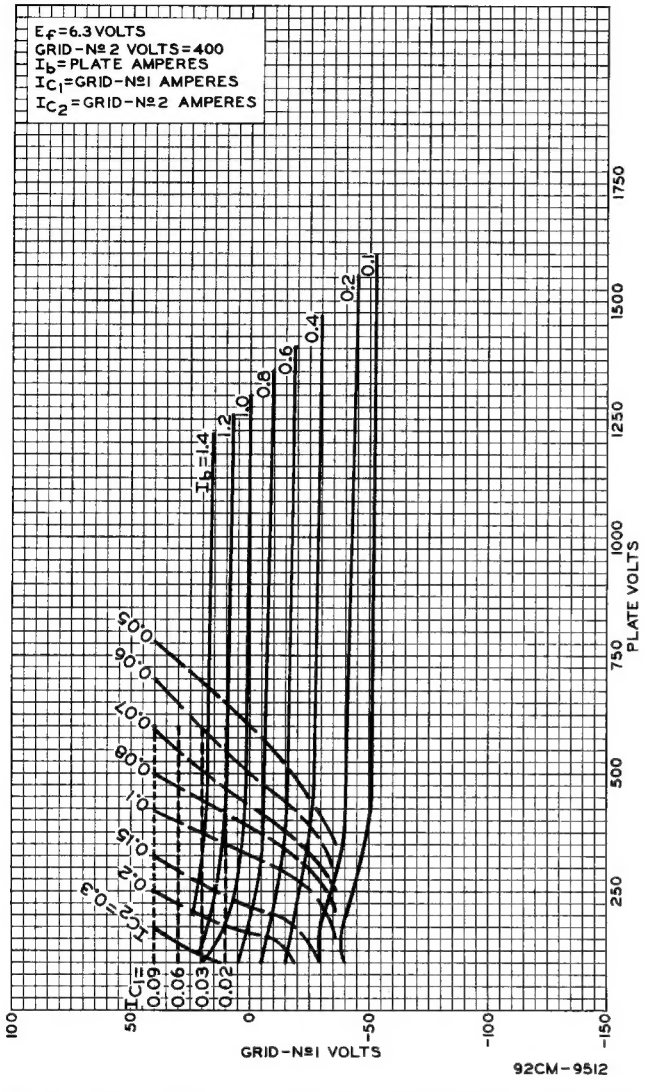


Fig.5 - Typical Constant-Current Characteristics for Type 7094.

The *driver stage* for the 7094 in either class C telephony or telegraphy service should have considerably more output capability than the typical driving power shown in the tabulated data in order to permit considerable range of adjustment, and also to provide for losses in the grid-No.1 circuit and the coupling circuit. This recommendation is particularly important near the rated maximum frequency where circuit losses, radiation losses, and transit-time losses increase. These losses have been taken into account in the values of driver power output shown under Typical Operation.

Highest operating efficiency in high-frequency service, and therefore maximum power output, will be obtained when the 7094 is operated under load conditions such that the maximum rated plate current flows at the plate voltage which will give maximum rated input.

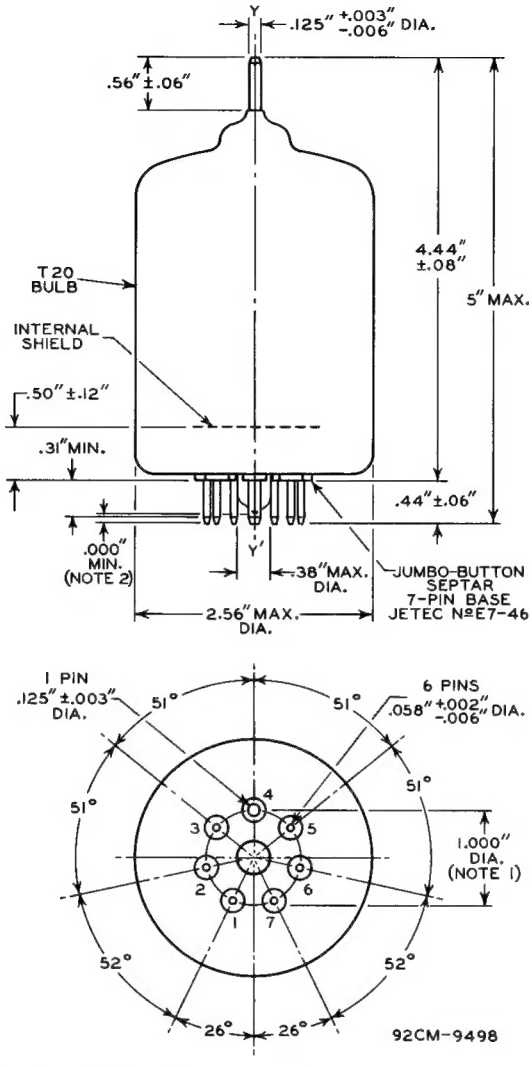
In *plate-modulated class C amplifier service*, the 7094 can be modulated 100 per cent. The grid-No.2 voltage must be modulated simultaneously with the plate voltage so that the ratio of grid-No.2 voltage to plate voltage remains constant. Modulation of the grid-No.2 voltage can be accomplished either by connecting grid No.2 through a separate winding on the modulation transformer to the fixed grid-No.2 voltage supply, or by connecting grid No.2 through an audio-frequency choke of suitable impedance for low audio frequencies to the fixed grid-No.2 supply voltage. The supply end of the choke should be well bypassed to ground.

During standby periods in intermittent operation, it is recommended that the heater voltage be maintained at normal operating value when the period is less than 15 minutes; and that it be reduced to 80 per cent of normal when the period is between 15 minutes and 2 hours. For longer periods, the heater voltage should be turned off.

Push-pull or parallel circuit arrangements can be used when more radio-frequency power is required than can be obtained from a single 7094. Two 7094's in parallel or push-pull will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage from that required for a single tube. With either connection, the driving power required is approximately twice that for a single tube. The push-pull arrangement has the advantage of simplifying the balancing of high-frequency circuits.

Devices and arrangements shown or described herein may use patents of RCA or others. Information contained herein is furnished without responsibility by RCA for its use and without prejudice to RCA's patent rights.

DIMENSIONAL OUTLINE



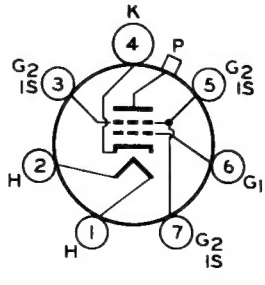
THE REFERENCE AXIS Y-Y' IS DEFINED AS THE AXIS OF THE BASE PIN GAUGE DESCRIBED IN NOTE 1:

NOTE 1: ANGULAR VARIATIONS BETWEEN PINS AND VARIATION IN PIN-CIRCLE DIAMETER ARE HELD TO TOLERANCES SUCH THAT PINS WILL ENTER TO A DISTANCE OF 0.375" A FLAT-PLATE BASE-PIN GAUGE HAVING SIX HOLES 0.0800" ± 0.0005" AND ONE HOLE 0.1450" ± 0.0005" ARRANGED ON A 1.0000" ± 0.0005" CIRCLE AT SPECIFIED ANGLES WITH TOLERANCE OF ± 5' FOR EACH ANGLE. GAUGE IS ALSO PROVIDED WITH A HOLE 0.500" ± 0.010" CONCENTRIC WITH PIN CIRCLE WHOSE CENTER IS ON THE AXIS Y-Y'.

NOTE 2: EXHAUST TIP WILL NOT EXTEND BEYOND THE PLANE WHICH PASSES THROUGH THE ENDS OF THE THREE LONGEST PINS.

SOCKET CONNECTIONS

Bottom View



PIN 1: HEATER
PIN 2: HEATER
PIN 3: GRID No.2, INTERNAL SHIELD
PIN 4: CATHODE
PIN 5: GRID No.2, INTERNAL SHIELD
PIN 6: GRID No.1
PIN 7: GRID No.2, INTERNAL SHIELD
P: PLATE